

Deck Replacement with Precast Concrete Segments

**Project J8S0654, Route 64, Hickory County
1st Precast Slab Panel Bridge in Missouri**

Background

The deck to be replaced in this project was on Bridge No. A0894, known as the Nemo Bridge. It was built in 1960 by the US Army Corps of Engineers over Pomme De Terre Lake. This 1698 ft. long steel bridge had wide flange girders with a 7 in. thick composite reinforced concrete deck. A preliminary survey showed that over 60% of the deck concrete was delaminated at the rebar level and that the deck needed replaced.

Bridge Plan Design

HNTB Company, the design consultants, had originally designed the deck to be built by conventional methods one lane width at a time, which would have taken 2 years and required one-way traffic on the bridge during the whole construction. Closing the bridge would have caused a 30-mile detour.

The Bridge Maintenance Engineer in MoDOT's Springfield District, David O'Connor, came back from a National Prefabricated Bridge Elements Conference in St. Louis and suggested to the Project Manager using full thickness pre-fabricated deck panels to speed up the construction of the Nemo Bridge. MoDOT received favorable response to this idea internally and also at an on-site public hearing. The local residents and business owners were very supportive and excited about the idea of less traffic disruption, especially on busy summer weekends when tourists, campers and fisherman are visiting.

HNTB then started redesigning the bridge plans, even though they were about 90% complete using the cast-in-place (CIP) method. It was decided to replace the deck by only closing the bridge on Sunday through Thursday nights from 7PM to 7AM between the Memorial Day weekend and the Labor Day weekend. HNTB and MoDOT thus designed a precast deck system, using 10 ft. long precast sections with the barrier attached, to allow overnight replacement of at least 30 feet of bridge deck per night. The project was let on March 19, 2004 and awarded to Columbia Curb and Gutter Co. (CC&G) for \$5.5 million. The project also included replacing expansion joints, re-painting of the entire superstructure and replacement of the abutment backwalls. To offset some of the costs of the prefabricated deck panels \$160,000 of federal Innovative Bridge Research and Construction (IBRC) funds were used.

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Innovative Construction Methods

The new plans called for removing the old deck, cleaning and preparing the tops of the girders and setting the panels each night and leaving a small transition between the new deck and the old using steel plates as a bridge and riding surface. The contractor CC&G believed the removal and preparing of the girders, which entailed removing the concrete deck, curb and railing, removing the old shear connectors, and painting the top of the girders, and then having time to set the panels would take too long to get good production every night. They proposed and got permission to fabricate 5–10 ft. long temporary bridge deck sections. In this way a crew could remove the old deck and clean and prepare up to 50 feet ahead of the crew placing new panels. Additionally they didn't have to set a certain number of panels in order to get the bridge open by 7:00 AM. It would cost them \$143 in damages per every 5 minutes that both lanes of the bridge were not completely open to traffic.

CC&G also used some innovative methods to cast the deck sections. They formed a 25'x 350' on site casting bed, which allowed match casting of 10 ft. panels for the entire length of a continuous section of bridge span between expansion joints. (See Figure 1) They used the casting beds 5 times in order to precast panels for the 5 continuous bridge span sections on the 1700 ft. long bridge. To simplify casting and reduce weight they obtained permission to cast only the deck and not the barrier walls, and also to cast the crown of the roadway into the bottom and top of the slabs. The barrier curb was formed and poured after the whole new bridge deck was in place. Casting the barrier continuously actually provided a stronger structure because it added the beam

action of the barrier curb onto the composite deck. design and strength to the barrier by eliminating an un-reinforced joint every 10 ft.

Setting of the panels consisted of setting the haunch elevations, which the contract called on doing with foam strips. However, CC&G used an old CIP forming system using panel jacks. (See Figure 2) They attached the panel jacks to the steel girders and used angle iron pieces as forms that rested against each edge of the top flange to form the haunches. They screwed the jacks to get the angle iron to the correct grade and then set the panels on top of the angle iron. After the panels were set new shear studs were welded on the girders through blockouts left in the casting. Eight 1" diam. post-tensioning bars were attached to the preceding panel and tensioned and then the haunches of each girder were filled with fast setting mortar poured through the stud blockouts. When the grout reached strength of 2500 psi the panels could be opened to traffic. (Special grout was injected around the epoxy coated post tensioning bars at a later date.)

CC&G used the old posts and channel rail barrier as temporary guardrail on the new wider sections placed every night that transitioned exactly to the temporary bridge sections. The temporary bridge sections filled any gap left at the end of the night between the precast deck sections to the removed edge of the original deck ahead. There was a small transition in the bridge rail from the new wider deck to the old narrow one, but the old concrete deck was cut off to leave no gap in the roadway surfaces and only required some cold mix asphalt patch to transition from the higher elevation from the new 8" deck sections to the old 7" deck. Steel deck plates were hardly ever needed as the riding surface. The placing of all the 162 deck panels and making

Figure 1: Casting Bed (Every other 10' section has concrete poured burlap curing mats on it and the others with green rebar and blockouts showing are waiting to be match cast.)



Figure 2: Setting first precast panel at night. Note: 1. Leveling system on girders, 2. Rebar sticking out at curb to pour the barrier later, 3. Temporary steel grid bridge section in foreground.



closure pours at new expansion joints was completed by Labor Day. The bridge then was closed as needed in one direction to pour the cast-in-place slip formed barrier curb and after that a 1 in. thick Silica Fume concrete deck overlay which provided a smooth uniform riding surface. Because of all the access pockets left in the castings that had to be grouted separately the deck surface might be rough. Additionally a dense concrete overlay would add some more safety from corrosion and concrete deterioration. However, an overlay might not be needed in some designs using prefabricated bridge sections.

Discussion

The contract all in all went smoother than expected because of the excellent work of the design group and innovative practices of the contractor. The contractor had to cast 162 precast sections and had only one 10-foot panel rejected. Because of forming on a long casting bed by continuous spans, the longitudinal alignment of the in place sections was almost perfect. CC&G set as many as eight

sections, 80 feet of new deck, in one night. They had no problem in setting the whole deck before Labor Day 2004 saving an entire year of construction and inconvenience to the public. MoDOT will benefit by replacing an old 7" thick badly deteriorated deck with a new 9" thick reinforced concrete deck with epoxy steel that will make the bridge even stronger than originally designed with a minimum of inconvenience to the summer tourism business. Also with the rehabilitation and painting of the steel and new expansion joints it will be like a brand new bridge and should add another 50 years to its life.

As far as the cost differential on this bridge using pre-fabricated sections, it was \$62.04/sq.ft. versus MoDOT's average cost of \$28.32 /sq.ft for replacing a deck by conventional methods. On this project however, being a very long bridge entirely over water and because of other circumstances it was considered the extra cost ultimately was very little. Jim Hartman the Project Manager explained, "We never really had a concrete difference in cost between

doing the traditional method verses the precast panel method. I believe he (the design consultant) agrees but the thinking was that the comparison in cost would be a wash out. There were some things that maybe were going to make the precast method construction more costly than the traditional method such as the fact that this was a new, undone procedure in our area. Undoubtedly, the new procedure will become cheaper to construct as it is done more often. The significant difference in construction time between the two procedures made up for the difference in cost by greatly reducing the traffic control cost between the two.” MoDOT has learned a lot about designing and construction of a prefabricated bridge deck and will look for unique applications where this type of construction can speed up construction and reduce traffic congestion.

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